CAVITY-BASED FUEL INJECTOR/FLAMEHOLDER CONCEPT FOR SUPERSONIC COMBUSTION APPLICATIONS HAS POTENTIAL

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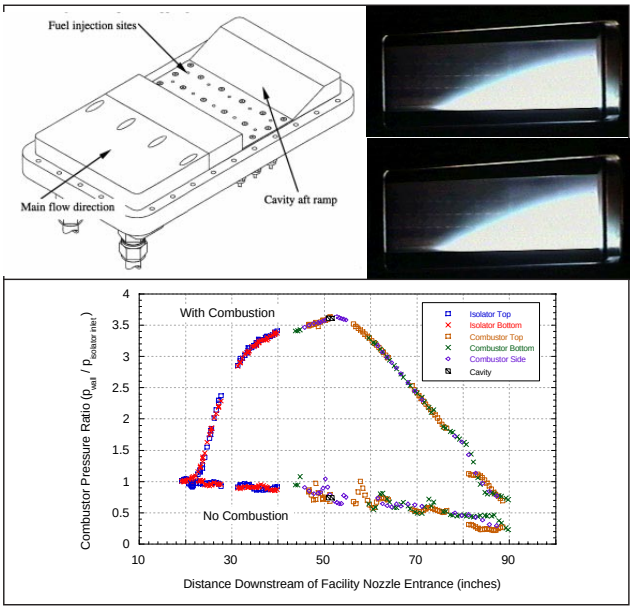

Payoff

The approach adopted by the Propulsion Directorate's High Speed Systems Development Branch has the potential to reduce the strict structural and cooling requirements associated with intrusive fuel injection and flameholding devices. It also has the possible payoff of eliminating burdensome external ignition systems and improving survivability and performance of the combustor.

Accomplishment

Under a research effort supported by the Hypersonic Technology (HyTech) Program, the High Speed Systems Development Branch successfully ignited and sustained combustion of a room temperature gaseous hydrocarbon fuel (ethylene) using a baseline fuel injector/flameholder concept that incorporates flush wall fuel injection upstream of a wall cavity. Combustor inlet flow properties simulate conditions corresponding to flight conditions between Mach 4 and 5 at dynamic pressures of 1000 psf. Video records of the flame zone show an intensely active combustion zone with very rapid flame spreading.

Background

Since 1996, the Propulsion Directorate has been involved with hydrocarbon-fueled scramjet component development and testing. The goals of this effort are to improve existing hydrocarbon scramjet combustor technology and to develop in-house expertise in the areas of scramjet combustor design, test, and performance analysis. The current state-of-the-art in hydrocarbon scramjet technology requires intrusive fuel injectors and flameholders. Such devices are difficult to maintain inside the extremely harsh environment of a scramjet combustor and are often very complex with severe internal drag penalties. In addition, external ignition aids are commonly employed at low flight Mach numbers (i.e., around M = 4) and may require scramjet-based systems to carry potentially heavy solid-fueled gas generators. These devices reduce available payload for fuel at the low speed takeover point. The approach taken by the Directorate's in-house team involves more high-risk/high-payoff concepts for fuel injection and flameholding in scramjet combustors. These concepts include flush-wall fuel injection, wall-mounted flameholding techniques, and techniques to enhance the atomization and vaporization characteristics of liquid fuels. Significant attention has been paid to documentation of the combustor performance using a wide array of conventional and advanced diagnostic techniques. Simultaneous thrust and calorimetry measurements are employed. When coupled with a dense array of pressure instrumentation (over 700 channels currently available), three independent methods of performance assessment are available.